PCT / SE 2004 / 0 0 2 0 4 5

PRV

PATENT- OCH REGISTRERINGSVERKET
Patentavdelningen

REC'D 18 JAN 2005
WIPO PCT

Intyg
Certificate

Härmed intygas att bifogade kopior överensstämmer med de handlingar som ursprungligen ingivits till Patent- och registreringsverket i nedannämnda ansökan.

This is to certify that the annexed is a true copy of the documents as originally filed with the Patent- and Registration Office in connection with the following patent application.

REGISTRERINGSVERKET • PA

(71) *Sökande* / *Applicant (s)* — *Telefonaktiebolaget L M Ericsson (publ), Stockholm SE*

(21) *Patentansökningsnummer* / *Patent application number* — *0303607-6*

(86) *Ingivningsdatum* / *Date of filing* — *2003-12-30*

Stockholm, 2005-01-07

För Patent- och registreringsverket
For the Patent- and Registration Office

Görel Gustafsson

Avgift
Fee

PRIORITY DOCUMENT
SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

BEST AVAILABLE COPY

PATENT- OCH REGISTRERINGSVERKET SWEDEN
Postadress/Adress Box 5055 S-102 42 STOCKHOLM
Telefon/Phone +46 8 782 25 00 Vx 08-782 25 00
Telex 17978 PATOREG S
Telefax +46 8 666 02 86 08-666 02 86

BANDWIDTH SIGNALLING

TECHNICAL FIELD

The present invention relates to signalling of available bandwidth especially in multicarrier wireless telecommunication systems.

BACKGROUND

The tendency in the field of wireless telecommunications is to use more and more bandwidth for services performed. However, the available spectrum is limited. This calls for a need of flexibility with respect to spectrum usage in the sense that pieces of radio spectrum of different size and in different locations should be used with basically the same radio air interface.

High data rate air interface needs to have a wide band spectrum signal that might be too wide for certain unused spectrum 'holes' that otherwise could be utilised.

For the sake of example, assume that the most demanding applications require that the system bandwidth needs to be 100 MHz. International standardisation and regulatory bodies will therefore have to make sure that there will be ample spectrum available so that a number of 100 MHz bands could be offered to the customers. However, it is also likely that certain regions will have smaller pieces of spectrum available here and there that are smaller than 100 MHz, say a 30 MHz band here and a 66 MHz band there.

One possibility is to design many different air interfaces for a number of bandwidths - say 30, 66 and 100 MHz - and let the base stations and mobile users choose one or several of them depending on the situation, say a 20MHz air interface for the 30MHz band, a 50MHz interface for the 66 MHz band and 100 MHz interface for the 100MHz band. This choosing by the parties leaves some parts of the spectrum unused – 10 MHz in the 30 MHz band and 16 MHz in the 66 MHz band, while the 100 MHz band is fully used. Even if there is a high degree of commonality between different air interfaces, the complexity of equipment grows with several interfaces than with only one.

Another suggestion for better usage of available frequency spectrum is to let several operators share spectrum or rent or buy resources from each other. This should be done in a quite fast manner.

SUMMARY OF THE INVENTION

The proposals and ideas referred to above suffers from a number of drawbacks. Already mentioned is that using several parts of the spectrum causes greater complexity. Another is that available pieces of spectrum might be to big for certain applications which leads to waste of resources. Still another problem is how to inform the users of the existence and extent of free spectrum for a certain application at a certain moment in a certain location area. In other words there is a need for greater flexibility and fast allocation of resources whenever the users so request.

The solution is presented in the appended claims relating to a method and means for signalling the availability of spectrum in terms of bandwidth and location.

The invention is advantageously implemented in wireless multicarrier system where the total maximum bandwidth is made up of a large number of narrow banded carriers like for example in Orthogonal Frequency Divisional Multiplexing, OFDM, Interleaved Frequency Divisional Multiplex, IFDM or similar. In OFDM and IFDM the sub carriers are ideally mutually orthogonal due to the pulse shaping employed. Generally, very similar systems can be designed with pulse shapes that make the sub carriers slightly non-orthogonal but that have other good properties, for example better spectral properties. This difference does not have a bearing on the invention so when OFDM is mentioned in the examples below, also these other more general types of systems are applicable. The only thing that is important is that the system consists of a large number of sub carriers.

A multicarrier system of the kind mentioned has the important advantage of dividing a piece of spectrum in almost an exact number of carriers to each user without much loss of bandwidth, at most just a few carriers, in the borderland between the bands allocated to two neibouring users. This makes the multicarrier system suitable for a system where the demand for bandwidth among the users has a varying pattern. A problem with this varying pattern is how to inform the users of where and with which size an available block of spectrum could be found. The invention solves this problem by including this size and location information within the blocks themselves.

The information about which set of downlink carriers in a block that is available is sent downlink from the base station on an acquisition, a broadcasting or some other cell covering channel. The set of carriers represent the total number for all users. At least one easily detected downlink channel must be transmitted which is within an operational band known to the mobile user and contains information about where this operational band starts and stops relative to the location of said downlink channel. It is enough if the user has a rough idea of where the operational band can be found. This kind of information could have been broadcasted to the user in an earlier cell search.

The format of the information about the size and location of the operational band could vary. Here are some examples:

- A start and stop frequency or frequency number is given absolutely or relative to the location of the channel containing this information.
- A start frequency or frequency number, absolutely or relatively specified plus a number of maximum carriers or fraction of that number.
- An identifying number where said identifying number identifies an operational bandwidth from a list of predefined operational bandwidths.

As soon as the mobile is informed of the available resources he may access a suitable channel representing his needs in the normal way well known to a person skilled in the art.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention, together with further aspects and advantages is exemplified by reference to a number of embodiments and accompanying drawings wherein:

Fig 1 shows a frequency spectrum exemplifying bands available in a typical situation.

Fig 2 shows a similar spectrum with indication of which carriers that carries the information according the invention.

Fig 3 is a further illustration of the how the information is transferred.

Fig 4 is an overview of the system according to the invention.

DETAILED DESCRIPTION

In figure 1 a typical spectrum is shown, divided into three blocks I, II and III of 100 MHz, the maximal system bandwidth in this example. The spectrum is partly shared by two operators A and B. A has part I and B has part III while part II is shared between the both operators, part IIa belonging to A and part IIb belonging to B. The figure thus shows four operational bands, I, IIa, IIb and III. It is assumed that by negotiation between the operators that the border b between A and B is changed from time to time depending on the demand from the subscribers of A and B respectively. The sharing distribution could of course be different. Fig 1 is just an example.

N is the number of sub carriers in each part. Let's assume that the 100 MHz band is divided into 4096 sub carriers of about 25 kHz, N=4096. In theory any number N could be activated making a large number of air interface bandwidths possible using just one air interface. This is a basic property of these types of systems. An individual user can, at different moments, have say 10, 270 or 4000 carriers to its' disposal, varying with demands and user behaviour.

Assume that the mobile user knows or can guess the approximate location of all N carriers (N=4096 in the example).

First the mobile user must detect the presence of one or more acquisition channels for cell search purposes. Such channels are designed so that there is a very small probability to mistake them for other types of signals, or for other types of signals to be mistaken for acquisition signals. In general the user must scan all possible locations to find this signal in order to unambiguously find one. Then the mobile knows that this channel lies within the operational bandwidth. After that the information in this acquisition channel about the size and location of actual carrier set is read.

As an example the acquisition channel is represented by one or more of the carriers of block I in figure 1. Then the information tells the user that the band starts at f1 and stops at f2 and that the bandwidth is f2 – f1.

Alternatively, based on acquisition channel information, the mobile finds the Broadcast Control Channel, BCCH, of the system, and reads the bandwidth information there or part could be read from acquisition channel and part from the BCCH channel.

A further embodiment is illustrated in figure 2. This figure is similar to figure 1 with the difference that the bandwidth information carriers are bold marked. The system information carriers are spread out among all possible sub bands of the operational band. Operator A 's signalling is as follows: In the 4 bold sub carriers to the left in block I, information says that the bandwidth is 100 MHz and all sub bands are used i.e. the whole 100 MHz band, the next two defines a bandwidth of about 70 MHz in block II. Operator B's signalling is as follows: The first bold sub carrier defines a ca 30 MHz system bandwidth in block II, and the next four in block III define a full 100 MHz bandwidth.

Included in figure 2 is a piece of unused spectrum in block II that comprises a few sub carriers that act as guard bands between the two generally unsynchronized and uncoordinated operators. This is sometimes beneficial.

If the operators, in some real time resource exchange or the like, decide that all bandwidth in the second block II should go to operator A, then operator B simply gracefully finalise or reallocate traffic from the allotted carriers in this block, signals that the resource in block II is closed for random access attempts, and stops transmitting in this band, while operator A starts to signal that the entire100 MHz block is now available for its subscribers.

Since the terminals periodically read bandwidth information from the downlink control channels this process could be made very quickly, in the order of milliseconds. Also, the terminals has or could have a full bandwidth detector running which makes it trivial to quickly start (de-)multiplexing data (from) to the newly available sub bands.

In figure 3 the invention is exemplified with a full system of 32 carriers of which only 13 are used. Within these 13 carriers the information about the system bandwidth is signalled. The information may alternatively include the mere fact that these specific 13 carriers are used. The information is mapped onto carriers that are more or less equally distributed, every forth carrier for illustrative purposes in figure 3.

In figure 3 and 4 the bandwidth information is repeated in every forth carrier for illustrative purposes as mentioned above. In practice, however, the distribution is much more thinly spread out in order not to waste bandwidth. In a 4096 carrier band the information may be carried on every 128th or 256th carrier occupying less than one percent of the total bandwidth.

In figure 4 an overview of the system according to the invention is shown. A traffic control centre, TCC, is connected over suitable interfaces to a number of base station transceivers BS, only one shown in the figure. The base stations have connections with several mobile stations, MS1 and MS2 in the figure. The TCC has an over all control of the traffic in the system and one of its tasks is to collect information about the availability of bandwidth of particular parts of radio spectrum used in the system. The information is transferred to the base stations and from there transmitted on a broadcast channel or the like to the users, MS. The TCC is connected to public networks like the internet. The TCC may also have connections with other TCCs belonging to other operators and after negotiations taking over smaller or greater parts of spectrum from them or vice versa.

A user, MS1 in figure 4 for example, entering the location area of the system scans the broadcasted channel sent out by the base station for information about available bandwidth and location in the spectrum according to the invention. MS1, having received the information in receiver R, stores it into a memory M. After entering the scanning is repeatedly performed for changing conditions and the memory is updated.

To conclude the invention has the following advantages:

- The base station uses basically the same signalling method for any operational bandwidth.
- The mobiles use basically the same detection method for any operational bandwidth.
- The mobile user can use the same detector in OFDM-like systems regardless of the bandwidth used in a specific cell at a specific time
- The mobile user can quickly detect changes in spectrum allocations.
- The invention gives regulators (national or international) flexibility to allocate different sized spectrum pieces for use with basically the same equipment.
- The invention gives operatorsthe technical means to trade spectrum in real time.
- Furthermore, when regulatory conditions change the operational bandwidth can be changed quickly with the mobile station still being able to follow what is happening.

CLAIMS

1. Method in a multicarrier wireless telecommunication system interchanging radio communication between base stations (BS) and mobile user stations (MS) of the system, wherein information signals are transmitted over the air interface relating to operational bands (I, IIa, IIb,III) of the radio spectrum used by the system and having specified properties ***characterised in*** that the signalling comprises information of the size and location in the spectrum of the bands (I, IIa, IIb,III) as part of the information in one or several sub carriers of the bands.

2. The method of claim 1 wherein the signalling is received (R) by the mobile users (MS) which detects the information about available blocks of spectrum and stores it into a memory (M)

3. The method of claim 1 or 2 wherein the size information is repeated regularly in subsequent carriers of the operational band.

4. The method of claim 1-3 wherein the information comprises the start and stop frequencies (f1,f2) of the band and thereby the bandwidth (f2-f1).

5. The method of claim 2 wherein the mobile (MS) repeatedly scans the information signalling for updating its memory (M) about changing conditions relating to the operational bands (I, IIa, IIb,III).

6. The method of any of the preceding claims wherein the operational bands (I, IIa, IIb,III) belong to different operators (A, B) and wherein the subscribers of the different operators may partly or wholly have access to each others operational bands.

7. A wireless multicarrier telecommunication system including transmitting units (BS) controlled by a traffic controlling centre (TCC) and whereby the transmitting units have means to transmit information signals to mobile units (MS) using the system relating to available resources of the system **characterised in** that the information signals comprises information about the size and location of available bandwidth in a number of operational bands (I, II, III).allocated to the system.

8. Abase station node(BS) in a multicarrier telecommunication system comprising transmitting means for transmitting information relating to properties of available operational bands (I, IIa, IIb,III) of the spectrum allocated to the system **characterised in** that the transmitting means include means for transferring data related to size and location of the available operational bands.

9. A mobile station node (MS) in a multicarrier telecommunication system characterised in that it comprises means (R) for receiving information relating to available operational bands (I, IIa, IIb,III) in terms of size and location in the radio spectrum.

10. The mobile station of claim 9 wherein it comprises further memory means (M) for storing the operational band relating size data.

ABSTRACT

The invention relates to bandwidth signalling in a multicarrier wireless telecommunication system. The information is transferred in the band itself and contains information of the size and location of the band. The information is repeated in a number of carriers through out the band.

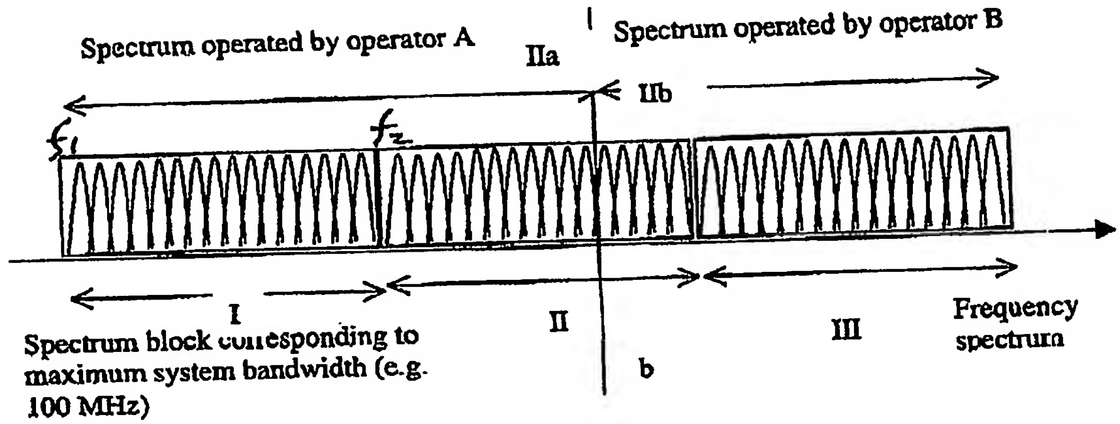

Spectrum operated by operator A
IIa
Spectrum operated by operator B
IIb
f_1
f_2
I
II
III
Spectrum block corresponding to maximum system bandwidth (e.g. 100 MHz)
b
Frequency spectrum

Fig 1

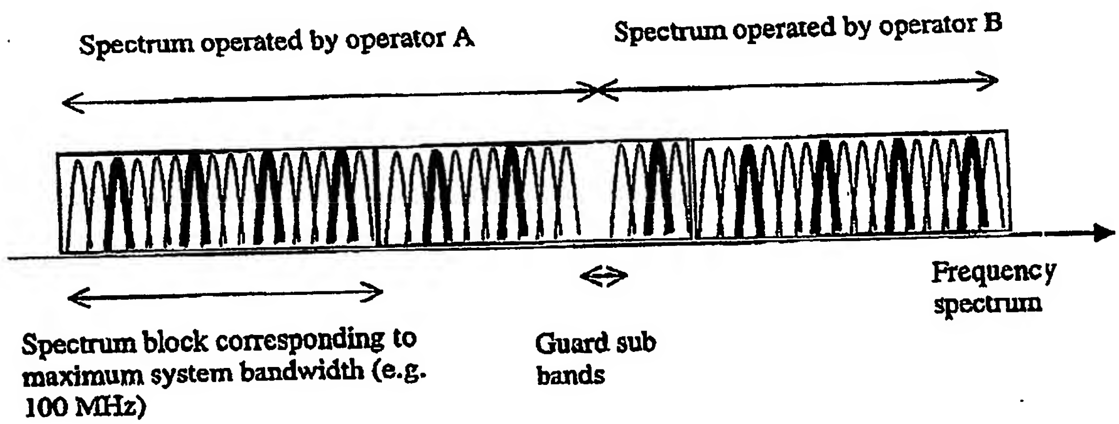

Spectrum operated by operator A
Spectrum operated by operator B
Frequency spectrum
Spectrum block corresponding to maximum system bandwidth (e.g. 100 MHz)
Guard sub bands

Fig 2

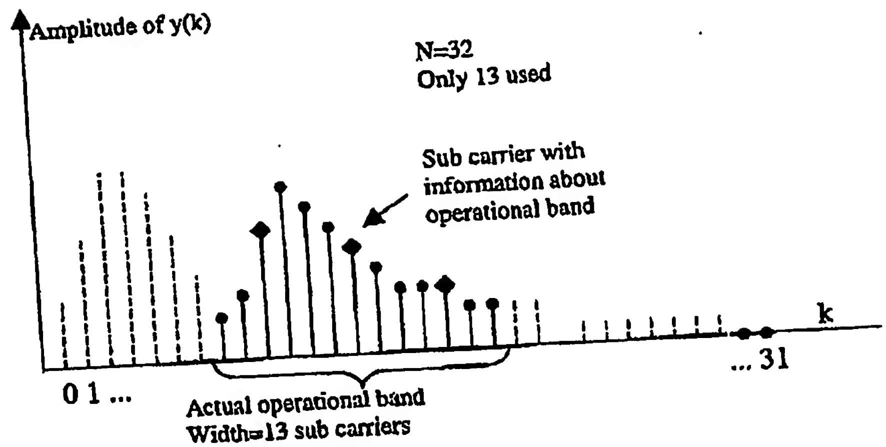
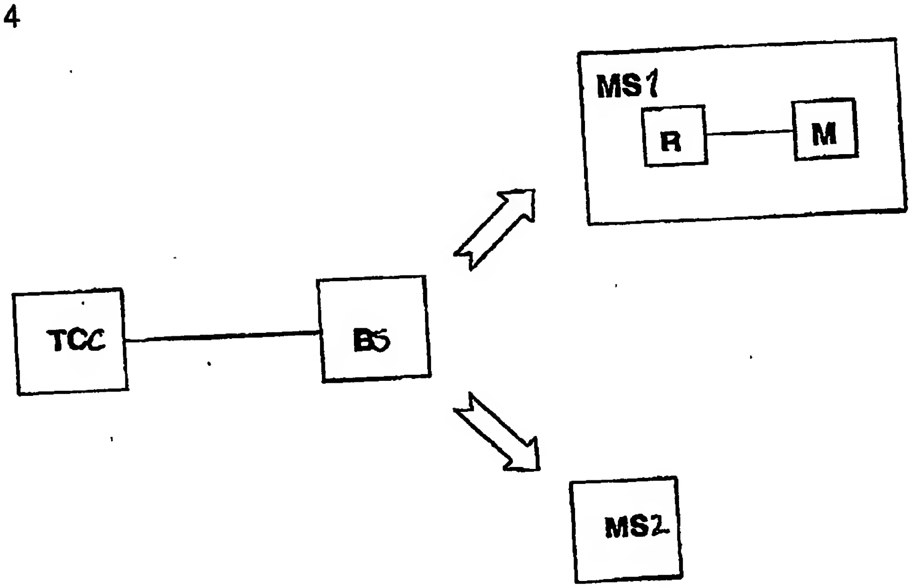

Amplitude of y(k)
N=32
Only 13 used
Sub carrier with information about operational band
k
0 1 ...
... 31
Actual operational band
Width=13 sub carriers

Fig 3

Fig 4


MS1
R
M
TCC
BS
MS2